Simulate the Effect of Social Distancing

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Programming Language & Tool

Initial Parameters

Notation	Description	Value
N	Square Matrix Dimension	100
M	Initial Population	1,000
X	Initial Infection Rate	0.3%
P_m	Mobility	80%
P_d	Death	3%
K	Average Infection Period	6
R	Number of Runs	10,000

Experiment Description

- Total, Max Infection Rate and Total Death Rate are measured and averaged from 10,000 runs of each configuration with different *S*, i.e. percentage of population that are stationary
- Mobile populations continuously move in one direction until colliding with another person/the border of the map, then change to a random different direction
- Infection time ~ Exp(λ), λ = 1/K = 0.167

How I Generate the Initial Board Configuration

1. M random coordinates are selected using the `random.sample` function

```
Population = random.sample([(x, y) for x in range(N) for y in range(N)], M)
```

2. Then randomly infect the population and mark part of the population as mobile. These two processes occur independently.

```
infectedPopulation = random.sample(population, init_infections)
mobilePopulation = random.sample(population, math.ceil(M*(1-S*1.0/100)))
```

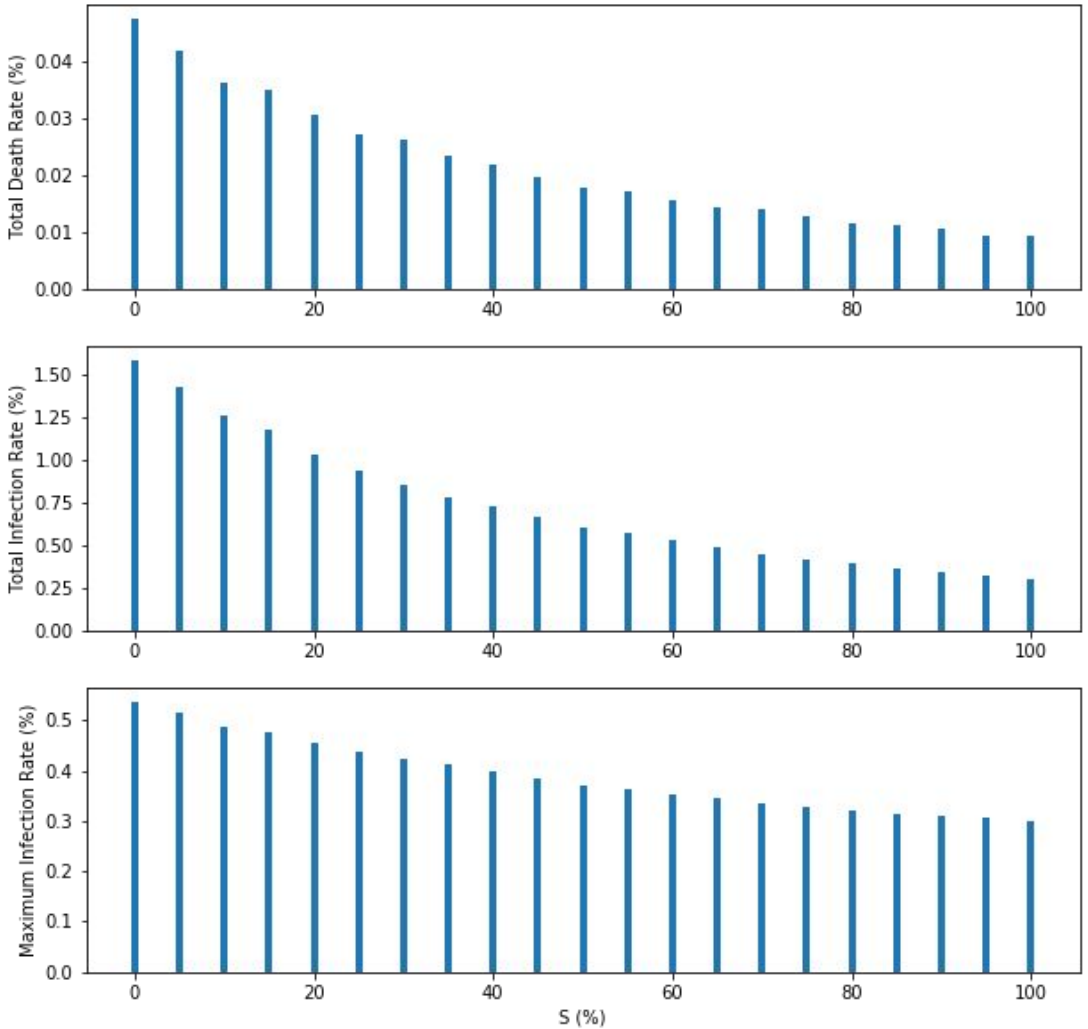
Moving Pattern & Constraints

1. There are 8 directions (N, NE, E, SE, S, SW, W, NW) a mobile person can move each turn, the probability of the moving is P_m
2. If a person encounters any of the following situations
   a. Collide with the edge of the map
   b. Collide with another person

   he/she will change their moving direction that is different from the current direction, i.e. if currently moving north, change to any direction other than north

```
def changeDir(direction):
    return Direction(random.choice(list(range(1, \
                    direction.value))+list(range(direction.value+1, 9))))
```

Results


Total Death Rate (%)
0.00
0.01
0.02
0.03
0.04
0
20
40
60
80
100
Total Infection Rate (%)
0.00
0.25
0.50
0.75
1.00
1.25
1.50
0
20
40
60
80
100
Maximum Infection Rate (%)
0.0
0.1
0.2
0.3
0.4
0.5
0
20
40
60
80
100
S (%)

Observations

- The shape of *Total Death Rate*, *Total Infection Rate* and *Maximum Infection Rate* resembles exponential decay as S (Percentage of the population that is stationary) increases.
- As S reaches 100%, i.e. the entire population practices social distancing
  - Total Infection Rate ≈ Initial Infection Rate
  - Maximum Infection Rate ≈ Initial Infection Rate
  - Total Death Rate ≈ Initial Infection Rate × Death Rate

Takeaways

- Social distancing works ! \(゜ヮ゜)/
- If the society practices social distancing as a whole, we can almost completely eliminate the spread of the disease (ノ◕ヮ◕)ノ*:・゜✧
- Partial social distancing expands the scale of the disease exponentially ゞ◎Д◎ゝゞ◎Д◎ゝゞ◎Д◎ゝ